

April 8, 1952

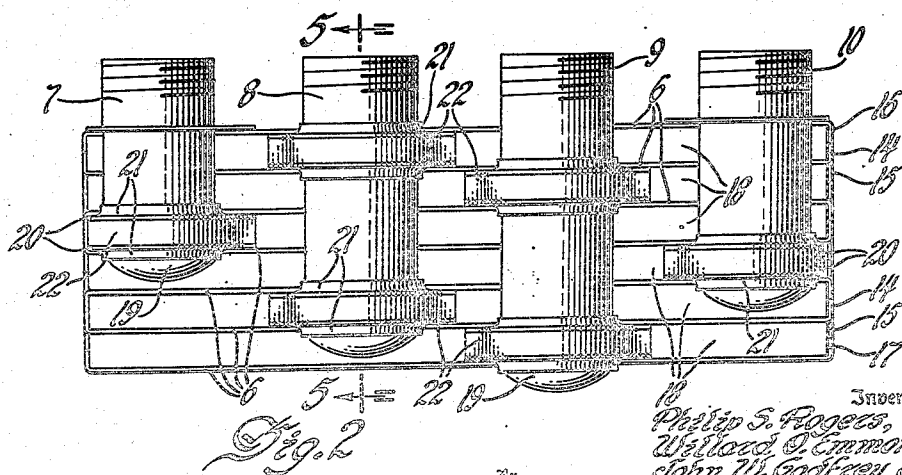
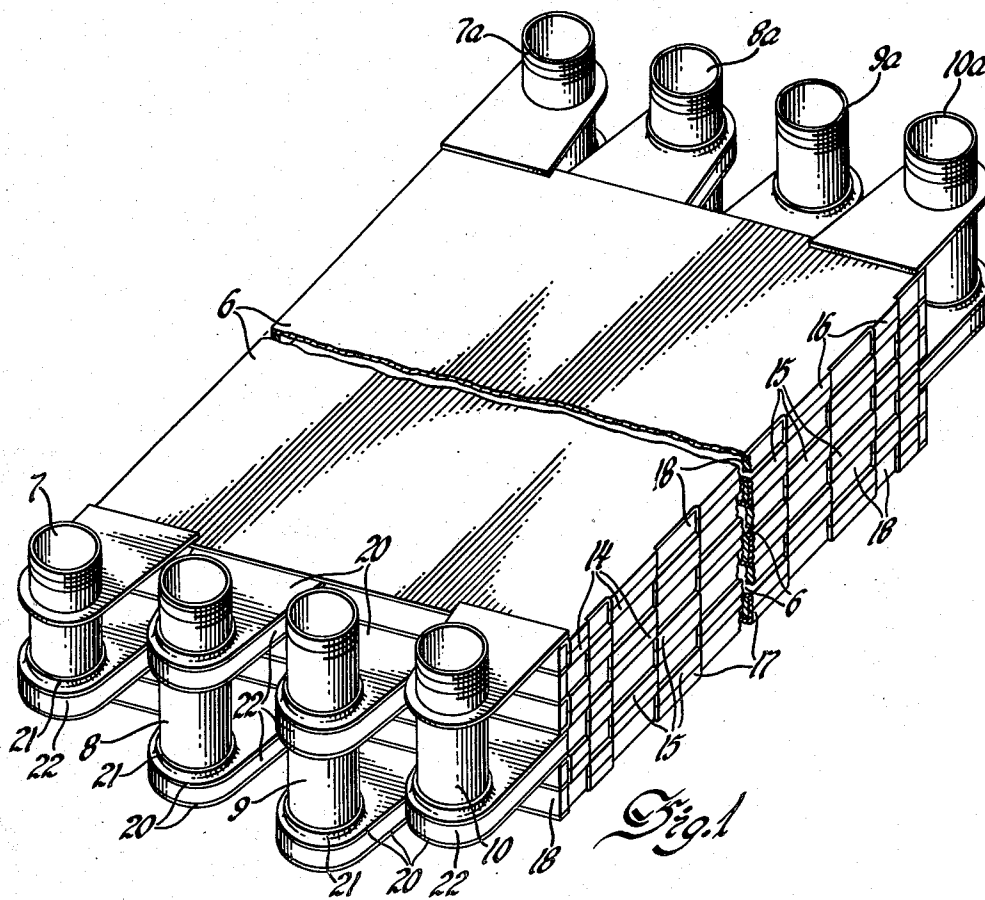
P. S. ROGERS ET AL

2,591,878

OXYGEN REGENERATOR

Filed Sept. 22, 1948

2 SHEETS—SHEET 1



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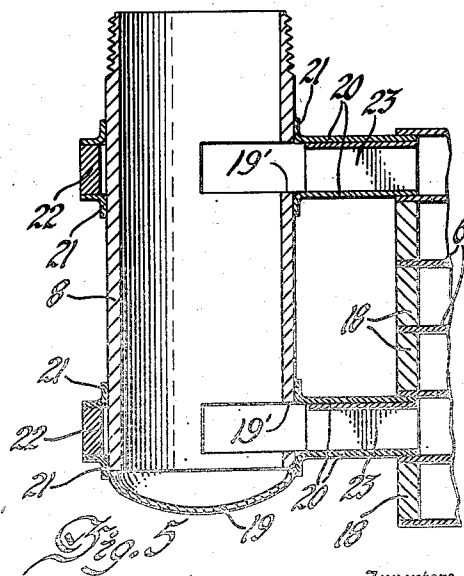
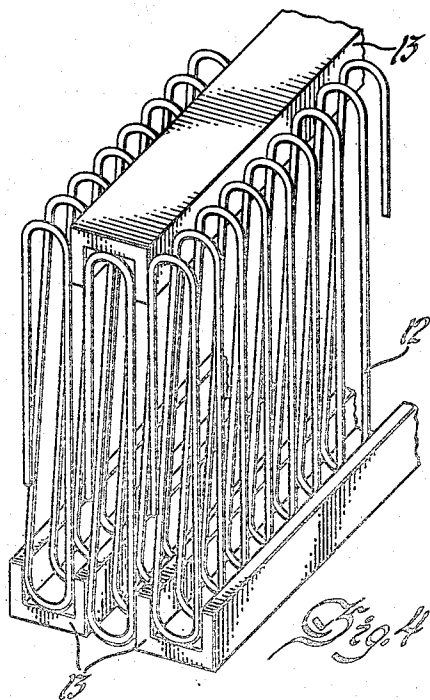
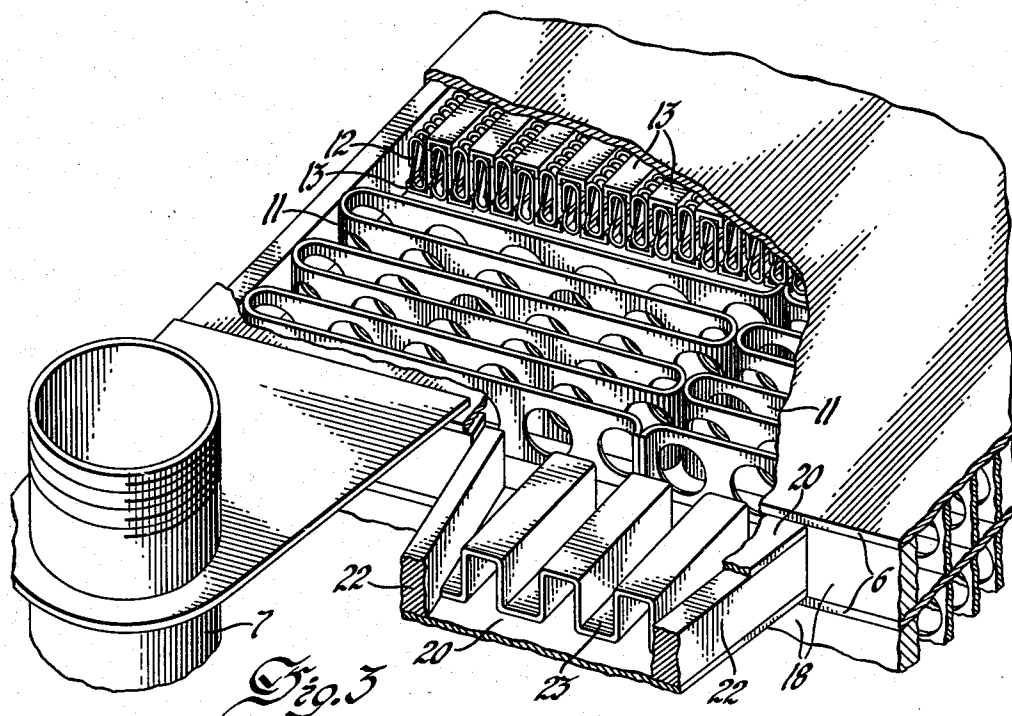
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UNITED STATES PATENT OFFICE

2,591,878

OXYGEN REGENERATOR

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Application September 22, 1948, Serial No. 50,496

6 Claims. (Cl. 257—245)

1

For the production of tonnage oxygen atmospheric air can be cooled to a very low temperature and then separated by distillation and rectification into its main constituents, namely, oxygen and nitrogen. Efficiency of the process is increased by pre-cooling the incoming compressed air and this conveniently and economically can be done through the utilization of cold oxygen produced by the process and the cold waste nitrogen. For working the low temperature products for the absorption of heat from the compressed air an oxygen regenerator can be employed and so arranged as to serve also as a purifier of the air by removal of normally present moisture and carbon dioxide. Purification is accomplished by the temperature drop in that as the air becomes very cold the impurities condense on the heat exchange surfaces over which the air sweeps. By periodically switching the paths of air and nitrogen through the device the nitrogen as it warms up in absorbing heat from the air acts to vaporize moisture and carbon dioxide previously deposited from the air and carries out the impurities to complete the cycle.

For working the fluids to best advantage it is important that an abundance of surface be exposed in the flow paths without too much restriction to flow and that relatively thin walls separate adjoining passages. It also is of consequence to incorporate ruggedness in the assembly of thin walls. These things are substantially achieved together with ease and simplicity of manufacture by the employment in general of a succession of spaced flat sheets closed at their edges to afford passages therebetween and held apart throughout their width and breadth by a multiplicity of spaced struts in the nature of small diameter pins arranged in rows and joined at opposite ends to the opposing faces of adjacent thin walls.

The thinness and multitude of pins provides large surface area exposed within the small passages and their arrangement in longitudinal rows narrowly spaced apart minimizes resistance to fluid flow while insuring the sweeping of the surface by a maximum number of fluid particles.

To avoid the need during manufacture and assembly for handling the pins individually it is here proposed that all pins of each successive pair of rows be formed of one continuous piece of wire which can be handled as a unit and this contemplates the use of a serpentine or helical coil having straight or flattened sides or a narrow elongated loop formation. Thus the long straight sides of each helix constitute a double

2

row of pins successively joined by return bends at their opposite ends.

An important feature of the present invention is the elimination of flexibility in the coiled wire during handling and the provision automatically for proper location in the assembly by fitting or nesting the return bends at least along one end within a channel section strip which gives stiffness and provides spacer flanges or separators for the neighboring lengths of coiled wire when they are placed side by side for brazing or like securement to the flat wall plates.

Other advantages will become apparent during the course of the following specification having reference to the accompanying drawings wherein Figure 1 is a perspective view of an oxygen regenerator; Figure 2 is an end view thereof; Figure 3 is a broken away fragment in perspective; Figure 4 is an enlarged detail perspective of a few rows of coils with end loop locator channels fitted alternately to opposite ends of neighboring helical lengths of wire and Figure 5 is a section on line 5—5 of Figure 2.

In the drawings the assembly is illustrated as comprising a group of flat plates 6 in superposed spaced relation affording a stack of fluid flow passages which communicate selectively at one end with connector pipes or tubes 7, 8, 9 and 10 and at the opposite end with similar connector pipes 7a, 8a, 9a and 10a.

As shown there are six passages and as best seen in Figure 2 it will be noted that the first and the fifth passages are joined with the connector tubes 8 and 8a; that the second and sixth passages are joined with connector tubes 9 and 9a; that the third passage is joined with the connector tubes 7 and 7a and that the fourth passage is joined with the connector tubes 10 and 10a. The construction is such that the unit may be placed in the oxygen producing system for fluid flow in either direction. The several connector tubes are to be coupled by suitable valving which controls the flow of fluids through the passages. Thus in one setting of the selector valves the connector tubes 10 and 10a will carry oxygen after having been separated in the processing treatment; the connector tubes 7 and 7a will carry unbalanced air; the connector tubes 9 and 9a will carry compressed air to be treated and whose temperature is to be lowered beforehand with an accompanying deposit of impurities and the connector tubes 8 and 8a will carry cold nitrogen. As an example of a resetting of the valves the compressed air to be chilled will be directed through the passages joined with the

3

tubes 8 and 8a and the waste nitrogen will be directed through the passages joined by the connector tubes 9 and 9a and in taking on heat will vaporize and carry away those impurities previously deposited in the passages.

A stack of thin wall plates, while promoting rapid heat transfer and having the advantage of lightweight, have a more important significance with reference to making up a smaller and more efficient package with great ruggedness by supplementing the wall surface area through the use of internal stiffening struts secured to the walls and extending across the passages. Thus in the regions near opposite ends of each passage it is proposed to insert the serpentine ribbons 11 set on edge for brazed attachment to the opposing faces of passage walls with their successive straight lengths extending transversely of the passage. These strips 11 are apertured or formed throughout their length with a series of spaced and relatively large openings and since they are located immediately adjacent the fluid inlet and outlet connections which occupy a relatively small part of the width of the passage they serve not only as stiffeners and as increased radiation surfaces but also as spreader baffles for the incoming fluid flow in that the fluid traveling from end to end will be more uniformly distributed throughout the passage. Through the intermediate length of each passage and extending in longitudinal rows transversely spaced apart are the pin struts 12, each joined at opposite ends to the opposing surfaces of the passage and extending on a straight line across the passage space.

By making the pins 12 of small diameter in relation to their length and spacing them closely together a very large number can be accommodated and they insure an abundance of surface area for carrying heat to and from the walls and for exposure to fluid flow. Their arrangement in rows minimizes fluid resistance. They are here constituted by successive straight runs of flattened helical coils of wire. The elongated convolutions are wrapped on a flat mandrel or otherwise formed so that successive wire pins have their opposite ends joined by return bends or end loops. Thus each continuous piece of helical wire consists of two spaced apart rows of spaced apart pins together with opposite end connecting loops. It is proposed that all the loops at least at one end of the elongated convolutions shall be nested or fitted within a channel section stiffener strip 13. By fitting the channel to the coils as a subassembly the pins will be securely located and held against deflection and injury and rendered more convenient to handle. The several wire subassemblies may be placed side by side with the end channels alternately arranged for fixed abutment with the opposing faces of the passage walls. In this fashion the side flanges of the channels serve to space apart the neighboring wire helices at both the top and bottom, as viewed in Figure 4, with the flanges of the alternately disposed channels cooperating in succession and being aligned in pairs in common planes.

For ease of manufacture each intermediate wall plate 6 is transversely slitted for a short distance inwardly at each side and the material between the slits is alternately pressed upwardly as at 14 and downwardly as at 15 and preferably also formed with terminal outwardly extending bottoming flanges, not shown. Similar formations extending downwardly, as at 16, on the uppermost wall plate and upwardly, as at 17, on the

4

lowermost wall plate are also provided and the purpose of these several tabs is merely to space and locate the plates during the assembly operation and the subsequent brazing operation. Thereafter all of the tabs or if desired only the outwardly extending terminal portions may be sheared off completely.

For leakproof closure of the sides and ends of the passages between the stack of plates and for increased structural strength at the sides there are employed spacer bars 18 of relatively thick material inserted between the successive plates 6-6 at their edges at all four sides of the assembly. The use of such bars for closing purposes enables the temporary spacer tabs to be sheared off, as previously referred to. The closure bars 18 in the opposite ends of the assembly are arranged so as to leave openings for communication with the respective connector tubes. Thus by reference to Figure 5 it will be seen that the connector tube 8 is a short length of pipe having screw threads formed on one end for coupling purposes and having its opposite end closed by a cap 19 and being formed with a pair of slots on one side in alignment with two of the passages in the plate stack. Each slot 19' is enclosed by top and bottom plates 20-20 having circular openings defined by marginal flanges or collars 21 into which the tube is fitted. Between the outer edges of the cooperating plates 20-20 is a U-shaped closure bar 22 to complete the fluid carrying conduit between the connector tube 8 and the heat exchanging passage. For adding stiffness a corrugated plate 23 is inserted between each set of plates 20-20 with its corrugations extending in the direction of flow and constituting struts which tie the plates together. In like manner communication is provided between the remaining passages and their respective connector tubes.

After the several parts have been preformed they are brought together into the final stack assembly relation and by means of suitable locating fixtures they are so held and then placed in a brazing oven and intimately bonded at all points of abutment. According to conventional practices the brazing material may be precoated on such contacting parts.

We claim:

1. In an oxygen regenerator or the like, a succession of superposed flat wall plates spaced apart, side and end closures for the spaces between the plates to thereby form a stack of sealed fluid flow passages, a series of inlet connectors arranged side by side at one end in selective communication with the fluid flow passages for delivery of several different fluids in staggered relation to successive fluid flow passages, a series of outlet connectors similarly arranged at the opposite end and each connector communicating with its fluid flow passage through an end closure for a distance constituting a small fraction of the passage width, apertured serpentine distributors located in the opposite ends of the passages and set on edge with opposite edges joined to the adjacent faces of said plates and thereby stiffening the plate assembly, a series of flattened coils of helically wound wire extending longitudinally of each passage in transversely spaced side by side relation and with spacers between adjoining side lengths of the adjoining flattened coils, said spacers comprising longitudinally extending channels fitted in nested relation to the coil end loops, one for each coil and arranged alternately on opposite end loops and secured by braz-

5

ing or the like to both the wire coils and the plate surfaces.

2. In combination, spaced apart conduit walls, a series of flattened coils of wire arranged side by side within the space between said walls and with their straight portions extending across the space and their return loop portions adjacent opposite walls, and elongated elements of channel shape in transverse section, one for each coil, fitted in nested relation to said loop portions, said elements being fitted to ends opposite one another on succeeding coils and being alternately secured to opposing wall faces with the flanges thereof cooperating with one another to bear on and space apart the neighboring coils, said return loop portions extending generally transversely of said channels.

3. In a device of the character described, flat walls spaced apart to provide fluid flow space therebetween extending between an inlet and an outlet, channeled locator strips secured in parallel spaced relation on the opposing faces of said walls with the channels carried by opposing faces in offset staggered relation and arranged so that successive channel side flanges, extending inwardly from each face, are uniformly spaced apart and in planes common to successive flanges on the opposing face and a group of pin struts extending between opposing wall faces, comprising a succession of flat helical coils of wire having spaced apart straight side strut portions successively joined at opposite ends by return bends which nest between and are secured to succeeding flanges, said return bends extending transversely of said channels.

4. In an oxygen regenerator or the like, a stack of superposed passages for the flow of several different fluids, the walls of adjacent passages being common to said adjacent passages, each passage including spaced apart flat wall plates and having an inlet and an outlet spaced apart and near opposite ends of the passage; a row of spaced apart perforated distributor strips positioned between said wall plates adjacent each of the opposite ends of the passage near the inlet and outlet respectively, with each strip corresponding in width to the space between said wall plates and being set on edge and extending in a plane substantially at right angles to said wall plates, said strips being joined along opposite edges to adjoining faces of both plates; and a group of spaced pins throughout the passage between said rows of distributor strips, said pins comprising the straight sides of a series of flattened helical coils of wire whose opposite end loops are joined to said plates.

6

5. In an oxygen regenerator or the like, a group of spaced apart flat wall plates affording fluid passages therebetween, each passage having an inlet and an outlet for the entry and exit of fluid; spacer pins within the passages comprising flattened helical coils of wire, each coil including two spaced apart rows of spaced apart pin portions, the successive pin portions in each row having their opposite ends joined by return bends to adjacent pins in the opposite row, said coils being arranged in side by side spaced apart relation; and elongated spacer flanges fitted between the pin portions of adjacent coils and being arranged alternately on opposite return bends of the coils and secured to said walls, said flanges extending in their longitudinal dimension generally transversely of said return bends.

6. Apparatus of the character described, including, means providing parallel spaced apart flat walls providing a fluid flow passage therebetween with an inlet and an outlet thereto; a plurality of flattened helical wire coils between the walls, each coil including two spaced apart rows of spaced apart pin portions extending at right angles to the surfaces of said walls, the successive pin portions in each row having their opposite ends joined by return bends to adjacent pins in the opposite row; and elongated coil spacing elements of channel shape in transverse section, said elements being fitted in nested relation over said return bends and having side flanges in bearing contact with adjacent coils to space said adjacent coils apart, said return bends extending generally transversely of said channel elements.

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